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A LIQUID FUEL SUPPLY UNIT FOR A LIQUID FUEL BURNER AND A LIQUID FUEL BURNER SYSTEM

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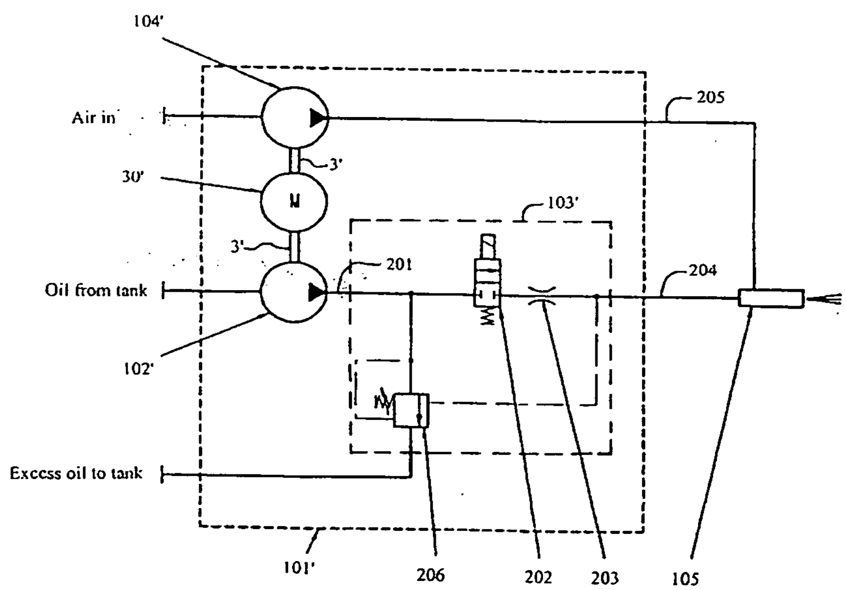

(57) Abstract: A liquid fuel burner system and a liquid fuel supply unit (101) for the liquid fuel burner (106) of the system are disclosed. The supply unit (101) comprises a liquid fuel feed pump (102), a compressor (104) and preferably also a motor (30) mounted on a common drive shaft (3). The system further comprises a modulatable liquid fuel metering device (103). The liquid fuel feed pump (102) is connectable to a liquid fuel conduit from a liquid fuel source, such as an oil tank. An outlet of the feed pump (102) is connected to an inlet of the liquid fuel metering device (103), which in turn is connectable to an atomizing nozzle (105) of the liquid fuel burner (106).

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A liquid fuel supply unit for a liquid fuel burner and a liquid fuel burner system.

The present invention relates to a liquid fuel supply unit for a liquid fuel burner and a liquid fuel burner system. Especially the invention relates to domestic heating the liquid fuel burner having a heat output of less than 10 kW.

Liquid fuel burners, such as oil burners, are quite common for domestic use. Ordinarily such oil burners are of the oil pressure atomizing type having high-pressure pumps delivering oil at high pressure. These burners operate on the principle that when oil under pressure is permitted to expand through a small orifice, it tends to break into a spray of very fine droplets, which are suitable for combustion. These burners are usually designed to operate with oil pressure as high as 3 MPa and viscosities of from 2 cSt. The principle upon which these burners operate requires that the pressure drop across the orifice be maintained high and as nearly constant as possible in order to achieve the necessary fine atomized droplets and also to avoid pulsating combustion. Because it is not possible to maintain the required atomization at lower pressure drop and thus lower flow, modulation or regulation of the heat output, in the operation of such burners has traditionally been very severely limited or has not been used at all, and the burners have been operated in an on-off mode only. This results in inferior temperature control, lower boiler efficiency and increased thermal load of the components, as they will experience a lot of heating and cooling cycles. On-off regulation also has a detrimental impact on the environments due to the many start-ups during which the combustion of the fuel is not optimal.

The minimum output of the burner is controlled by the size of the holes in the orifice. The smallest feasible holes are 0,1 mm in diameter, as smaller holes will clog very quickly due to inevitable particles in the oil or due to soot build-up from the combustion, increasing the need for maintenance to an intolerable level. The ordinary minimum output of oil burners having an orifice with the smallest holes possible, is about 10 kW, which exceeds the static demand of an ordinary household.

One such oil burner is known from US patent no. 5,692,680, which discloses a fuel supply unit for an oil burner. This fuel supply unit comprises a pump delivering pressurized fuel to a metering orifice, where the flow rate of fuel delivered can be regulated by regulating the pressure differential to maintain a constant flow independently of the elevation of the burner and the elevation of the tank with respect to the pumping unit. However, it is generally advantageous to have an adjustable flow rate of fuel to the burner, therefore this kind of supply unit is not desirable.

It has also been proposed to use burners in which a liquid fuel is gasified prior to the supply to the burner. These burners, however, require a significant start-up time, as the fuel must be heated to gasification temperature prior to start-up of the burner, and this kind of burners are mainly used for large industrial burners.

It has also been tried to operate liquid fuel burners on foamed liquid fuel. One such burner is disclosed in US patent no. 5,051,090 wherein the liquid fuel is foamed in a foam collection cylinder. This kind of burner is, however, only suited for large industrial burners.

EP-A-0 556 694 discloses a burner system for liquid fuel and provided for easy modulation to compensate for changes in fuel viscosity. The burner

system thus comprises a gas atomizing nozzle fed by an air compressor and a fuel pump, the fuel being fed through a regulator regulating on basis of a pressure difference.

US-A-4 391 580 discloses a system for supplying fuel to a pressure atomization fuel oil burner nozzle comprising a rotating gear pump with a rotatable valving structure for delivering fuel at pressure pulses and at a rate depending on the rotational speed of the pump, the rate thus being controllable. The system further comprises a blower driven by the same motor as the pump.

EP-A-0 013 488 discloses a unit comprising a fuel oil pump, a fan and a motor mounted on a common shaft and an electric circuit for controlling the unit.

As oil and most other liquid fuels are fossil fuels and hence a scarce resource, care should be taken to exploit the fuel to the utmost.

The object of the present invention is to provide a liquid fuel burner system which when applied to a boiler of a domestic heating system allows substantially continuous, modulate operation at least during the heating season.

A further object is to provide a unit for use in such a system.

According to the invention a liquid fuel supply unit for a liquid fuel burner with a gas atomizing nozzle, the supply unit comprising a liquid fuel feed pump and a compressor, said liquid fuel feed pump having an inlet connectable to a liquid fuel conduit from a liquid fuel source, such as an oil tank, and an outlet connectable to an inlet of a liquid fuel metering device, said compressor having an outlet being connectable to the gas atomizing nozzle of the liquid fuel burner, is characterized in that the unit comprise a common drive shaft for the liquid fuel feed pump and the compressor. Hereby is obtained a

unit which provides for low production costs and thus makes it feasible to provide a system according to the invention.

Preferably the liquid fuel feed pump and the compressor both comprise a rotary impeller mounted on the common drive shaft.

Also preferably the unit comprises a motor with a rotor connected to the common drive shaft. Preferably the motor is placed between the compressor and the liquid fuel feed pump. This provides for more maintenance friendly unit as the compressor and liquid fuel feed pump will be readily accessible.

The common drive shaft may be one element or it may comprise more interconnected shaft elements, which will facilitate manufacturing.

Further the unit may comprise a modulatable liquid fuel metering device, which may comprise a metering orifice and a valve. Alternatively the liquid fuel metering device is a metering pump, which may be a piston pump activated by an electro magnet.

In a preferred embodiment the compressor is a vane pump and the liquid fuel feed pump may be a gerotor pump.

A liquid fuel burner system according to the invention comprises a burner device with a gas atomizing burner nozzle, a fan for supplying combustion air to the burner device, and a liquid fuel supply unit, said unit being a constructional and exchangeable unit and comprising a liquid fuel feed pump and a compressor having a common drive shaft, the system further comprising a modulatable liquid fuel metering device fed by said liquid fuel feed pump, said gas atomizing burner nozzle being connected with the liquid fuel metering device and the compressor for receiving liquid fuel and atomising gas.

By means of the system according to the invention it is economically feasible to run a domestic heating device with a boiler and a liquid fuel burner

continuously during the heating season, thus avoiding the drawbacks related to operation in on-off mode.

Thus the burner device preferably has a minimum heat output of less than 10 kW.

In the following, the invention will explained in more detail by means of embodiments and with reference to the accompanying drawing, in which

Fig. 1 is an oblique view of a compressor,

Fig. 2 is an oblique view of a feed pump,

Fig. 3 is a side view of an assembled compressor-pump unit,

Fig. 4 is a cross-section along line IV-IV of the compressor-pump unit in Fig. 3,

Fig. 5 is a partial section along the line V-V in Fig. 4,

Fig. 6 is a diagram showing fuel and air flows in a heating system utilizing the compressor-pump unit,

Fig. 7 is a diagram showing a preferred embodiment of a liquid fuel supply unit, and

Fig. 8 shows a section corresponding to Fig. 5 but of a unit in a preferred embodiment.

For purposes of illustration, the present invention is embodied in a burner or heating system and a liquid fuel supply unit, such as may be used in pumping a low volume of fuel oil from a tank (not shown) to a burner nozzle in a household boiler.

Thus Fig. 6 shows diagrammatically a heating system with a liquid fuel supply unit 101 comprising a liquid fuel feed pump 102 connected to a metering device 103 and a compressor 104. The liquid fuel supply unit 101 is described in more detail with reference to Figs. 1-5. Further the heating system comprises a gas atomizing nozzle 105 fed by the supply unit 101, said nozzle 105 being attached to a burner 106, which is supplied with combustion air by a fan 107. The burner 106 is in turn attached to a boiler 108 of the domestic or household heating system. The

boiler 108 and the fan 107 may be of any suitable art. The burner 106 and nozzle 105 may also be of a known art.

The fuel supply unit 101, the fan 107, the nozzle 105 and the burner 106 together constitute a burner system.

The compressor 104 can be seen in Fig. 1 in partly disassembled state. The compressor 104 is a vane pump having an impeller 2 mounted on a drive shaft 3. The impeller 2 rotates in a housing 4 having an offset pump chamber 5. On rotation of the impeller 2 movable vanes 6 of the impeller 2 follows the inner wall of the pump chamber 5, so that gas, in the present example air, is drawn in through an inlet (not shown), compressed in the pump chamber 5 between the impeller 2, the housing 4 and the vanes 6, and delivered through an outlet (not shown). To function the compressor 104 must obviously be equipped with some kind of cover covering the pump chamber.

In Fig. 2 the feed pump 102 can be seen in partly disassembled state, as no cover is shown. The feed pump 102 is a gerotor pump (a kind of gear wheel pump known in the art) comprising a rotary impeller or gear wheel 8 mounted on the shaft 3 to be rotated thereby. The gear wheel 8 meshes with an internal toothing in an eccentrically mounted gear ring 9, thereby defining pump chambers of varying size to pump a liquid, in this case fuel oil, from an inlet to an outlet. Fig. 2 also shows the metering device 103, which in this embodiment is a metering pump, connected to the feed pump 102. The bearing housing 11 of the feed pump 102 comprises conduits for delivering oil from the feed pump 102 to the metering device 103 and conduits for the oil delivered from the metering device 103 to a metered oil outlet 12 (Fig. 4) in the bearing housing 11. As may be appreciated from Fig. 5 or when comparing Fig. 1 and 2, the feed pump 102 is mounted on the same drive shaft 3 as the

compressor 104, so that the housing of the feed pump 102 also act as cover for the compressor 104. The bearing housing 11 of the feed pump 102 further comprises conduits for compressed air from the compressor 104 to an atomizing gas outlet 13 in the bearing housing 11. Between the housing 4 of the compressor 104 and the bearing housing 11 of the feed pump 7, gaskets 14 are provided. The gaskets 14 are preferably made of carbon fibre sheet material to provide low friction bearings for the impeller 2 and sealing of the housing 4 to hinder leakage of compressed air.

The final assembly is the fuel supply unit 101 comprising the compressor 104, the feed pump 102 and a covering 15 of the feed pump 102 can be seen in Fig. 3, which is a side view of the assembly, and also the metering device 103. The extending end of the shaft 3 (Figs. 1 and 2) can be connected to a preferably electric motor. The motor may be an external component, but preferably it is incorporated in the liquid fuel supply unit 101 as shown at 30 in Fig. 4 and 5. Thus the compressor 104, the feed pump 102 and the motor 30 each have a rotor connected to the common shaft 3.

In the section of Fig. 4, it can be seen that the metering device 103 is inserted deeply into the bearing housing 11 of the feed pump 102. The metering device 103, which in this embodiment is a metering pump, comprises a piston 16 actuated by an electromagnet 17. Oil delivered from the metering device 103 passes a one-way valve, in this case a ball 18 biased by a spring 19 to close off the discharge opening of the metering device 103. From the discharge opening of the metering device 103, the oil enters a conduit 20 and continues to the outlet 12. Oil for the feed pump 102 enters through an inlet 21 and flows through conduits (not shown) to the feed pump 102. Excess oil from the feed pump 102 is directed to an outlet 22 through conduits (not shown) and through a pressure

regulating valve 23 ensuring that the oil pressure before the metering device 103 is maintained at a desired level e.g. 0.5 bar overpressure (1.5 bar absolute pressure). The output of the metering device 103 can be modulated with a rate of capacity of 1:5 or more between minimum and maximum. The modulation may be performed gradually or stepwise (e.g. two or three stages).

In the section of Fig. 5, it can be seen that the shaft 3 is connected to the impeller 2 of the compressor and to the gear wheel 8 of the feed pump, which gear wheel 8 meshes with an internal toothing of a gear ring 9. The impeller 2 comprises vanes 6 and rotates in the chamber 5 of the housing 4 of the compressor. In the bearing housing 11 of the feed pump, a conduit 24 for oil delivery to the metering device 103 is formed, whereas excess oil from the pump returns through a conduit 25 to the outlet 22 (see Fig. 4).

The burner system will comprise means for regulation including means for controlling the output from the metering device 103 and means for controlling the output of the fan 107 to obtain a proper relationship between the feeding rates of fuel oil and combustion air.

In an example the supply unit, as disclosed with reference to Figs. 1-5, for a burner of a domestic boiler operates with a feed pump delivering oil for the metering device at a rate of 20 l/h and at a pressure of 0.5 bar (overpressure). Oil for the burner is delivered by the metering device delivering oil at a rate of down to 0.5 l/h at an overpressure of 0.5 bar. The metering device is a piston pump, in which the piston is activated by an electromagnet, and the piston has a displacement of 2.8 mm^3 per stroke, which at a frequency of 50 Hz gives the above mentioned flow rate. The compressor delivers atomizing air at a rate of 1.3 m^3/h at a pressure of 0.3

bar. With this supply unit it is possible to obtain an output of the burner of less than 10 kW at continuous operation of the burner.

In stead of a metering pump the preferred embodiment of the liquid fuel supply unit of the present invention comprises as a metering device an orifice and a valve with a device for opening and closing said valve at intervals according to a heating demand.

Thus Fig. 7 shows a liquid fuel supply unit 101' comprising a liquid fuel feed pump 102', a compressor 104' and a motor 30' for driving the feed pump 102' and the compressor 104' through a common shaft 3'. The motor 30' is situated between the compressor 104' and the liquid fuel feed pump 102'. The common shaft 3' may be one element, or it may comprise two or three elements interconnected by couplings, possibly elastic couplings as it is known in the art to compensate for minor misalignments. An outlet of the feed pump 102 is through a conduit 201 connected to a metering device 103' comprising a shut-off valve 202 and an orifice 203. A conduit 204 leads fuel metered by the valve 202 and the orifice 203 to the gas atomizing nozzle 105 and a conduit 205 leads atomizing air from the compressor 104' to the nozzle 105. Fig. 7 also shows a pressure regulating valve 206 for regulating a pressure drop over the orifice 203 and for draining excess oil delivered from the feed pump 102'.

Fig. 8 shows a section of a unit in the preferred embodiment. For corresponding parts the same reference numerals are used as in Fig. 5. It can be seen that the shaft 3' is connected to the impeller 2 of the compressor 104' and to the gear wheel 8 of the feed pump 102', which gear wheel 8 meshes with an internal toothing of a gear ring 9. The impeller 2 comprises vanes 6 and rotates in the chamber 5 of the housing 4 of the compressor. In the bearing housing

11 of the feed pump, a conduit 24 for oil delivery to the metering device 103 is formed, whereas excess oil from the pump returns through a conduit 25 to the outlet. The electric motor 30' is situated between the compressor 104' and the liquid fuel feed pump 102' and comprises a rotor 31 connected to the shaft 3' and a stator 32.

In the preferred embodiment shown in Fig. 7 the modulation of the rate of feeding fuel to the nozzle 105 is performed by keeping a predetermined pressure differential across the orifice 203 (and the shut-off valve 202) by means of the pressure regulating valve 206 and opening and closing the shut-off valve 202 to meter or to deliver fuel to the orifice at a pulsing rate in accordance with heat demand. This mode of operation provides for modulating the heat output from a low output of approximately 1 kW (corresponding to approximately 0.16 l/h fuel oil) to a high output of 10-20 kW or more.

In the alternative the shut-off valve 207 may be kept open and the fuel delivery rate be regulated (metered) by regulating the pressure differential across the orifice 208 by means of the pressure regulating valve 211.

Whereas the delivery rates of fuel oil from the metering deice 103 and combustion air from the fan 107 are modulated according to heat effect needs, the compressor 104 and the feed pump 102 may be run at a constant rate. Thus a constant output from the compressor 104 of 30 l/h at 0.3 bar overpressure could be used. This rate corresponds to the need for combustion air at the low heat output of approximately 1 kW. Thus the combustion air fan may be turned off when the output from the metering device is modulated to its lower limit.

The described compact design of the supply unit as a constructional unit provides for easy assemblage during production of burners and also makes the sup-

ply unit ideal for retrofitting on an existing boiler for domestic use, possibly at a change from using gaseous fuel, such as natural gas, to a liquid fuel, such as fuel oil. Further the gathering of components: liquid fuel feed pump, compressor and possibly a liquid fuel metering device in a unit provides for easy exchange of such unit if necessary.

In case a metering pump is used several alternatives to the above-mentioned metering pump are envisaged:

A piston pump, possibly with commutation, could be used either driven by a separate motor or by the motor driving the compressor and the feed pump. If driven by a separate motor the metering may be modulated by varying the speed of the motor. Otherwise modulation may be obtained by varying the commutation.

Also a gear wheel pump with either internal or external gearing teeth, possibly with commutation, could be used either driven by a separate motor or by the motor driving the compressor and the feed pump. If driven by a separate motor the metering may be modulated by varying the speed of the motor. Otherwise modulation may be obtained by varying the commutation.

The invention is not restricted to the use of oil as the liquid fuel, and would work well with other kinds of liquid fuel. Further, the invention is not restricted to the use of air as the atomizing gas, other kinds of gases, e.g. an inert gas, such as nitrogen, or a gaseous fuel, such as propane, could be used if this should be advantageous in the given situation.

PATENT CLAIMS

1. A liquid fuel supply unit (101; 101') for a liquid fuel burner (106) with a gas atomizing nozzle (105), the supply unit (101; 101') comprising a liquid fuel feed pump (102; 102') and a compressor (104; 104'), said liquid fuel feed pump (102; 102') having an inlet (21) connectable to a liquid fuel conduit from a liquid fuel source, such as an oil tank, and an outlet connectable to an inlet (24) of a liquid fuel metering device (103; 103'), said compressor (104; 104') having an outlet being connectable to the gas atomizing nozzle (105) of the liquid fuel burner (106), characterized in that the unit comprise a common drive shaft (3; 3') for the liquid fuel feed pump (102; 102') and the compressor (104; 104').

2. A supply unit according to claim 1, characterized in that the liquid fuel feed pump (102; 102') and the compressor (104; 104') both comprise a rotary impeller (8; 2) mounted on the common drive shaft (3; 3').

3. A supply unit according to claims 1 or 2, characterized in comprising a motor (30; 30') with a rotor connected to the common drive shaft (3; 3').

4. A supply unit according to claim 3, characterized in that the motor is placed between the compressor and the liquid fuel feed pump.

5. A supply unit according to any of claims 1-4, characterized in that the common drive shaft comprises interconnected shaft elements.

6. A supply unit according to any of the claims 1-5, characterized in comprising a modulatable liquid fuel metering device (103; 103').

7. A supply unit according to claim 6, characterized in that the liquid fuel

metering device (103') comprise a metering orifice (203) and a valve (202; 206).

8. A supply unit according to claim 6, characterized in that the liquid fuel metering device (103) is a metering pump.

9. A supply unit according to claim 8, characterized in that the metering pump is a piston pump activated by an electro magnet (17)

10. A supply unit according to one of the claims 1-9, characterized in that the compressor (104; 104') is a vane pump.

11. A supply unit according to one of the claims 1-10, characterized in that the liquid fuel feed pump (102; 102') is a gerotor pump.

12. A liquid fuel burner system comprising a burner device (106) with a gas atomizing burner nozzle (105), a fan (107) for supplying combustion air to the burner device (106), and a liquid fuel supply unit (101; 101') said unit being a constructional and exchangeable unit and comprising a liquid fuel feed pump (102; 102') and a compressor (104; 104') having a common drive shaft (3; 3'), the system further comprising a modulatable liquid fuel metering device (103; 103') fed by said liquid fuel feed pump (102; 102'), said gas atomizing burner nozzle (105) being connected with the liquid fuel metering device (103; 103') and the compressor (104; 104') for receiving liquid fuel and atomising gas.

13. A liquid fuel burner system according to claim 12, characterized in that the burner device (106) has a minimum heat output of less than 10 kW.

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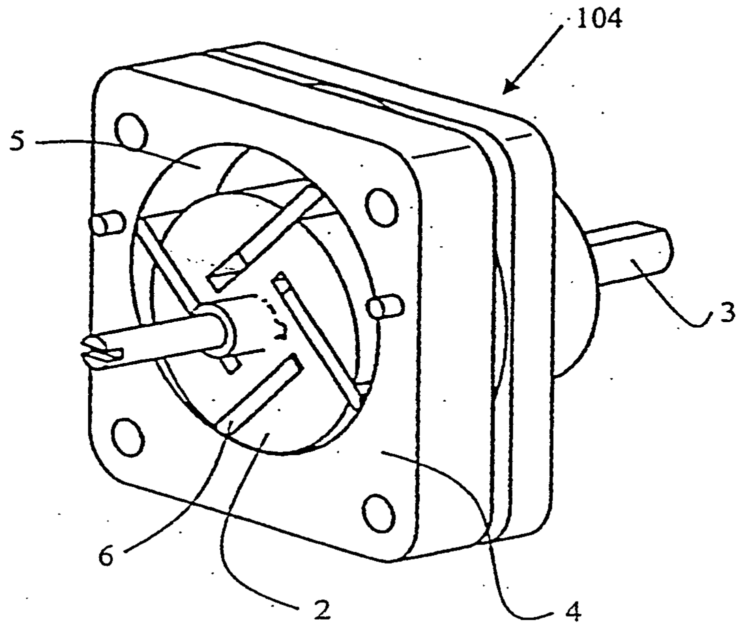

Fig. 1

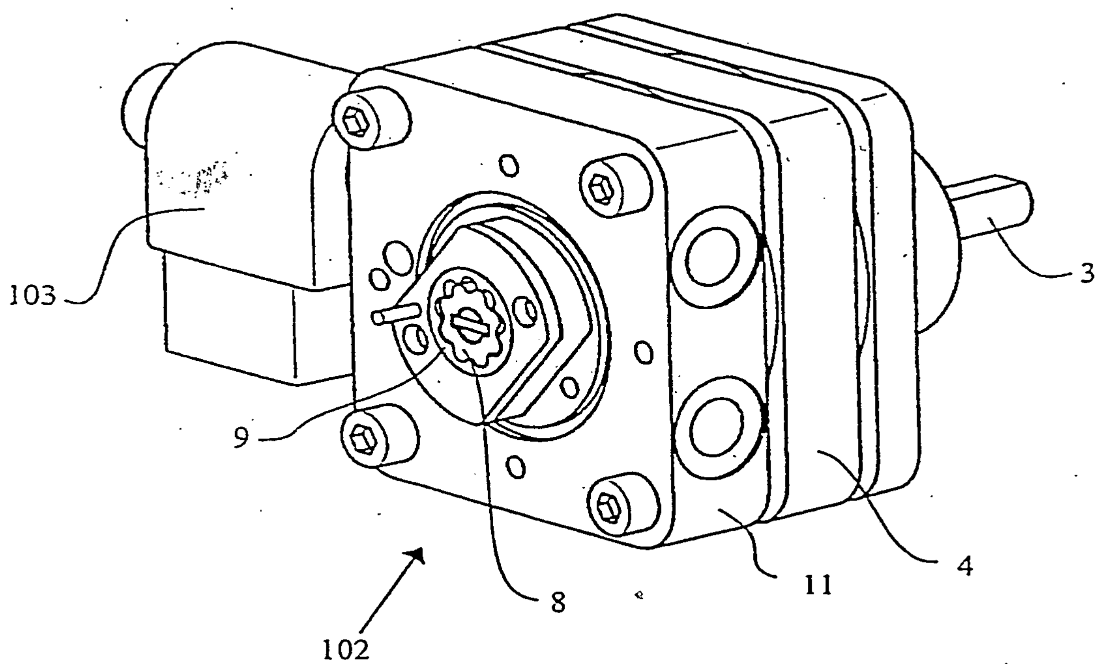

Fig. 2

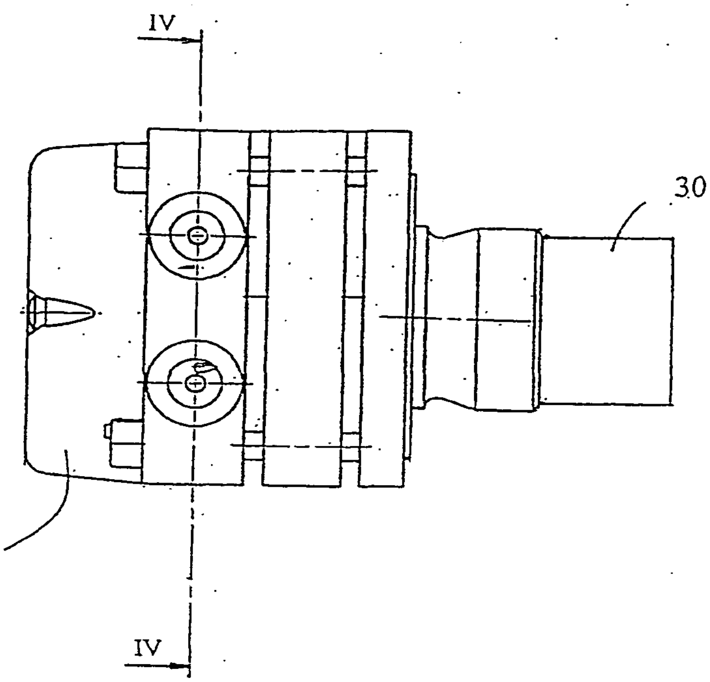

Fig. 3

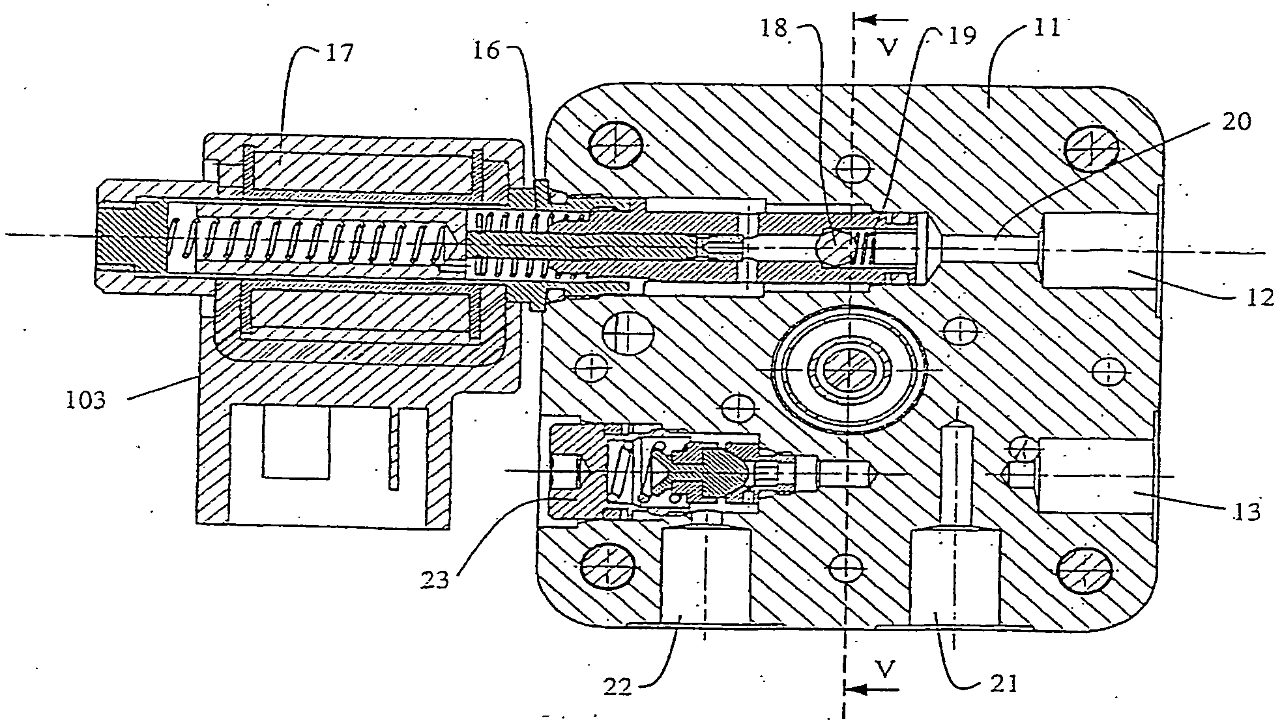

Fig. 4

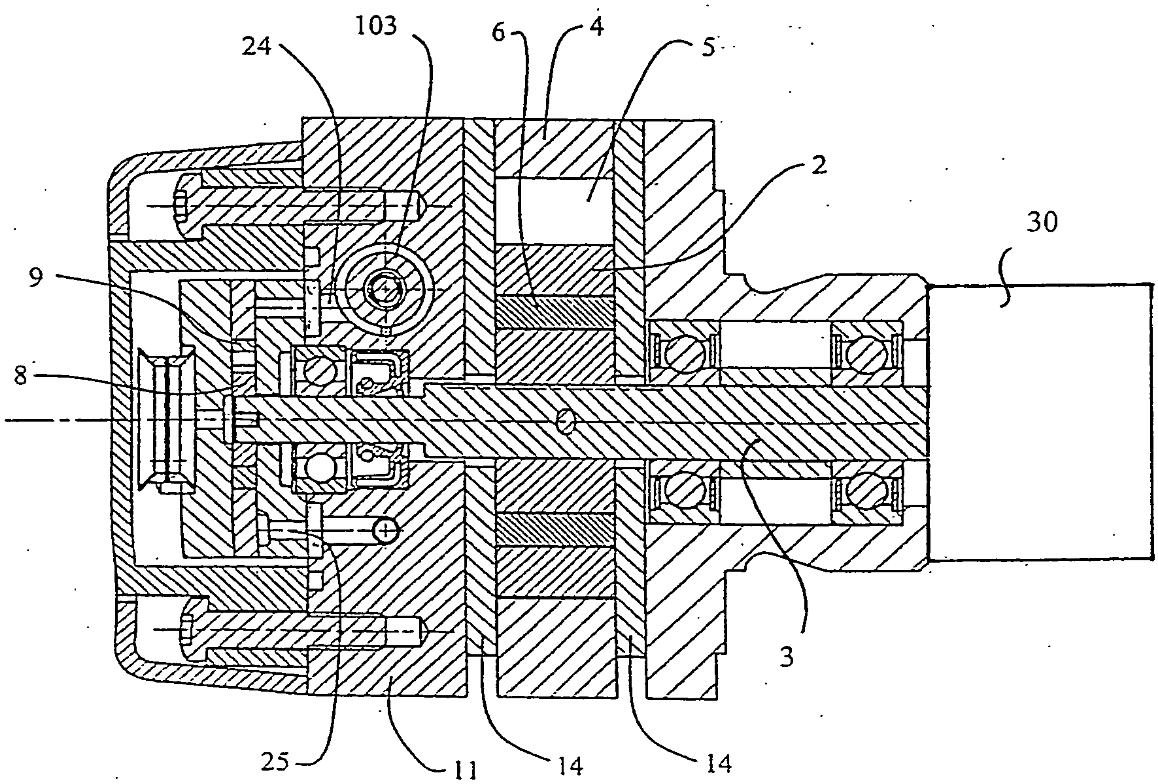

Fig. 5

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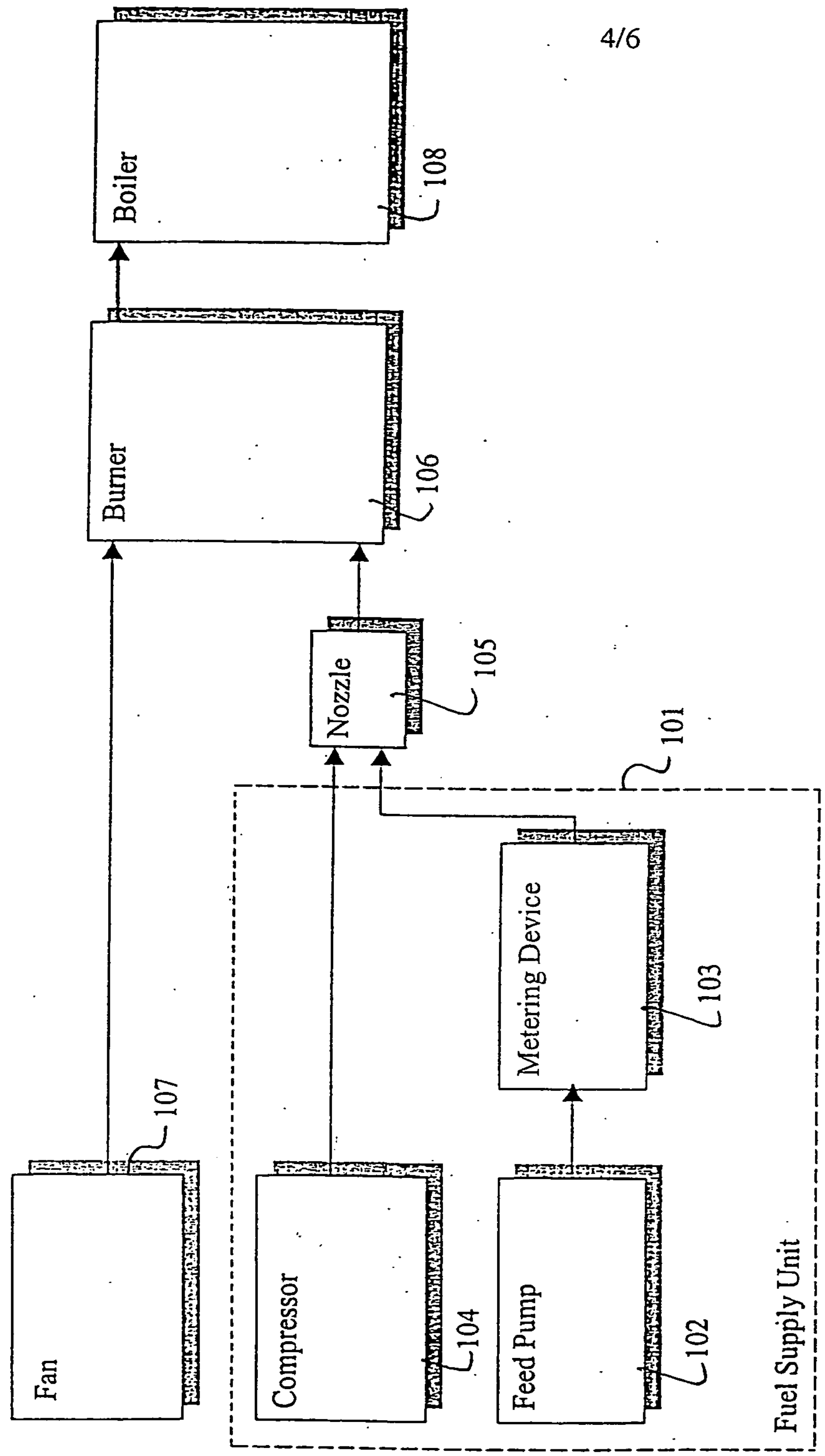

Fig. 6

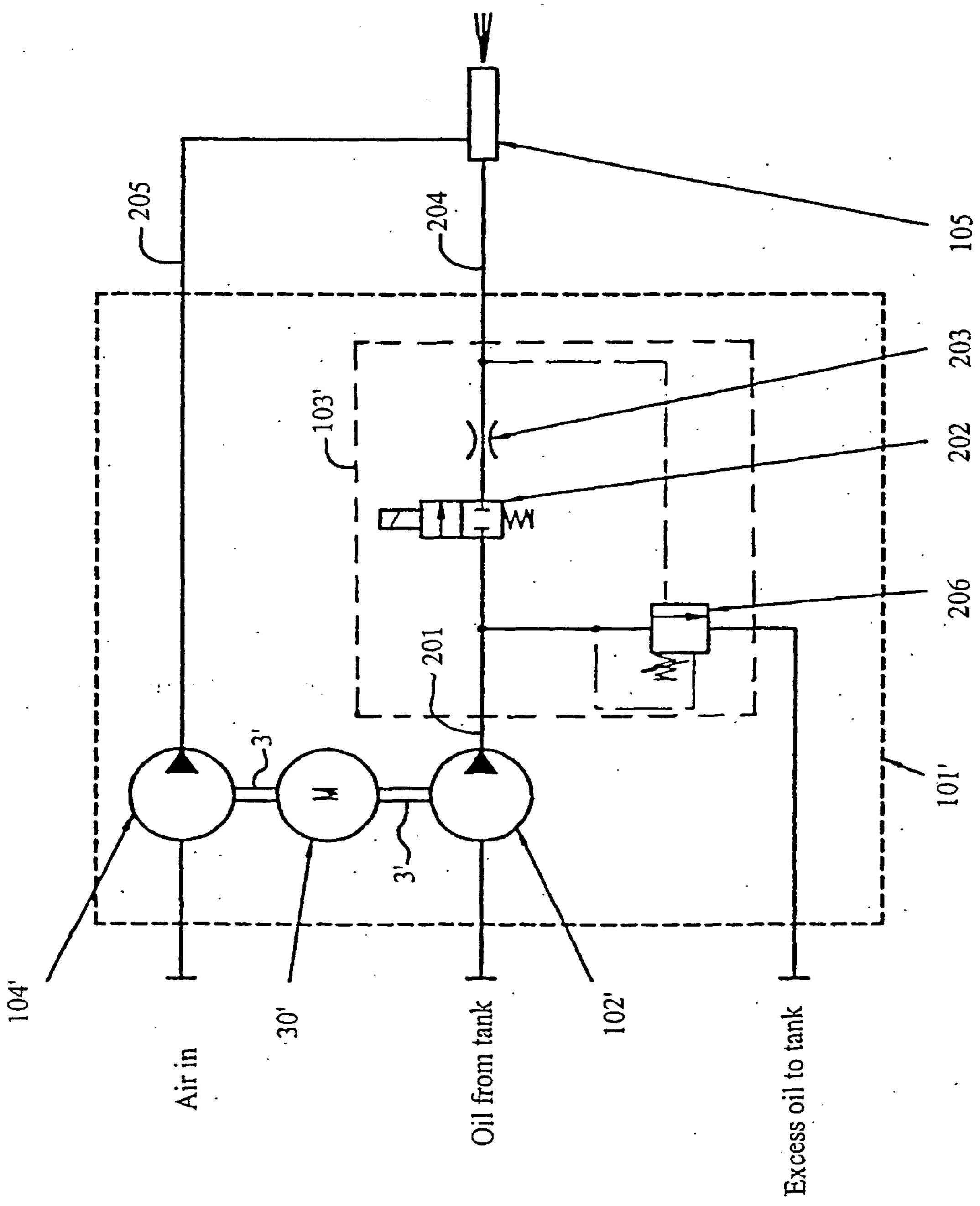
205
204
105
103'
203
202
206
201
3'
3'
101'
104'
30'
102'
Air in
Oil from tank
Excess oil to tank

Fig. 7

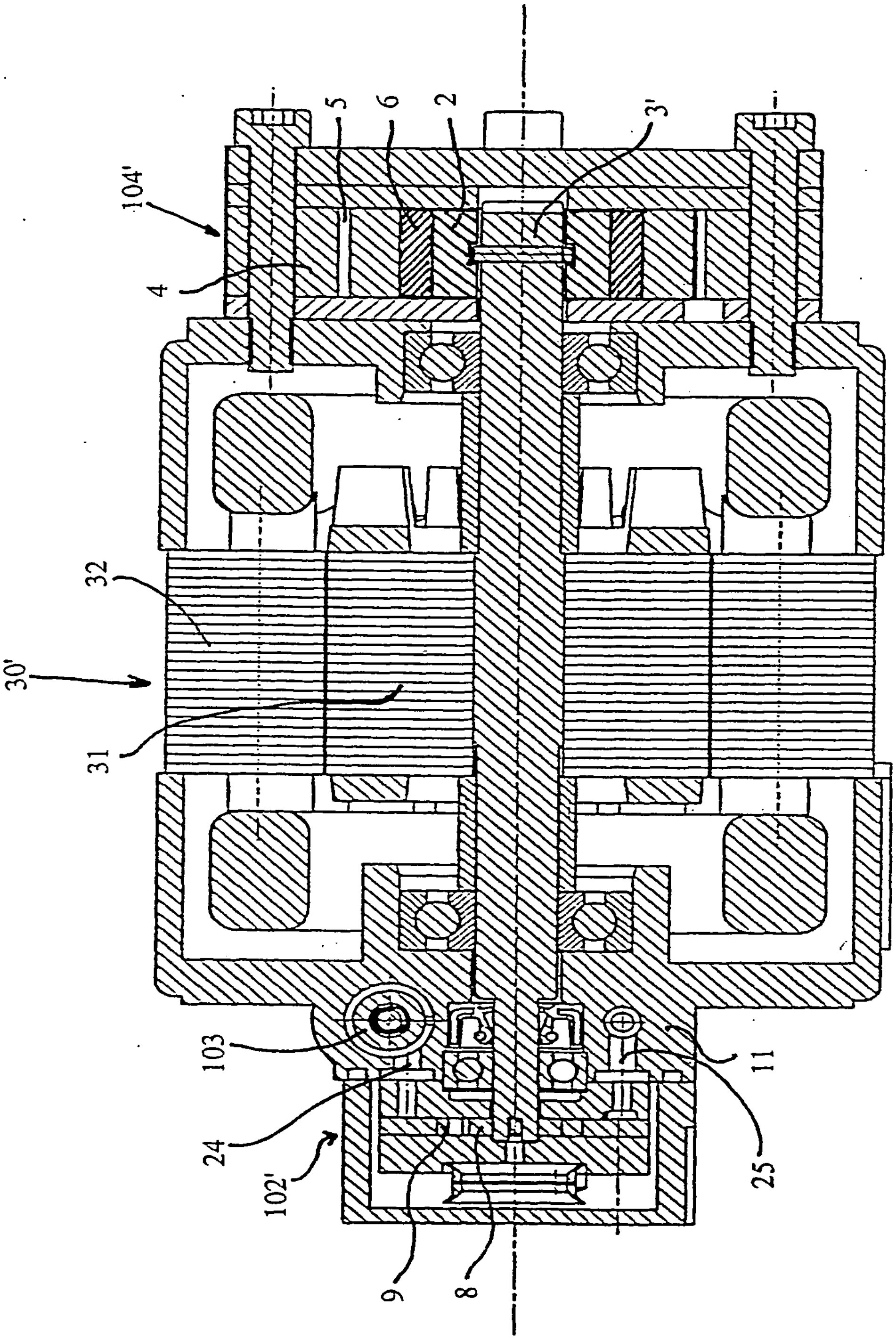

Fig. 8

INTERNATIONAL SEARCH REPORT

International Application No
PCT/DK 03/00733

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F23K5/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2 760 564 A (D.L. GETZ ET AL) 28 August 1956 (1956-08-28) column 3, line 21 - line 37 column 3, line 62 - line 72; figures 1,2 ---	1-13
X	US 2 832 403 A (ERIKSON ROBERT W) 29 April 1958 (1958-04-29) column 2, line 8 - line 20; figures 2,3 ---	1-13
X	US 2 117 512 A (SCOTT LEWIS L) 17 May 1938 (1938-05-17) column 2, line 10 - line 19 column 3, line 47 -column 4, line 22; figures 1,5 ---	1-13
A	US 4 391 580 A (HUNSBERGER DALE L ET AL) 5 July 1983 (1983-07-05) the whole document ---	1-13

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
27 January 2004	27.02.2004

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 692 680 A (HUNSBERGER DALE L ET AL) 2 December 1997 (1997-12-02) the whole document -----	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/DK 03/00733

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 2760564	A		NONE	
US 2832403	A	29-04-1958	NONE	
US 2117512	A	17-05-1938	NONE	
US 4391580	A	05-07-1983	NONE	
US 5692680	A	02-12-1997	NONE	